



Paralleling and Interconnection

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Kohler Power Systems



Agenda

- Kohler Company
- Distributed Generation
- National Connection Standards
- Product Information
- Typical Installations
- Critical Success Factors/Summary



Kohler Company

- Power Systems
 - Power Systems Americas, Engine Division, and Kohler Rental Power, Power Systems Asia, Power Systems Europe
- Kitchen and Bath
 - Kohler Plumbing, Sterling Plumbing, Kallista, Jacob Delafon,
 - Cabinetry and Tile - Ann Sacks Tile and Stone, Roborn, Canac
- Interiors
 - Baker, Milling Road, and McGuire Furniture
- Hospitality and Real Estate
 - American Club and Woodlake Inn Hotels/Resort
 - Blackwolf Run and Whistling Straits Golf Courses



Power Systems

Generators & Power Switching Equipment



Engines



Kohler Rental Power





Kohler Power Systems

Systems Expertise in...

- Healthcare
- “Big Box”, retail outlets
- Telecommunication
- Utilities
- Data centers
- Entertainment/Sports Recreation
- Commercial properties
- Agriculture
- Aircraft ground support vehicles
- Government - FAA, etc.
- Marine pleasure & commercial craft
- Residential
- Public Safety

Kohler Power Systems

In-house Design, Application & Manufacturing

- Industrial generators from 4 to 2000kW
- Marine generators to 170kW
- Mobile generators
- Automatic transfer switches to 4000 amps
- Low and medium voltage switchgear
- Uninterruptable power supply systems
- Microturbines
- Remote monitoring systems
- State-of-the-art controls
- Distributed generation grid connectivity solutions



Distributed Generation



Distributed Generation

Distributed Generation - Power generated at an end-users facility for other than emergency.

This would include generation used for:

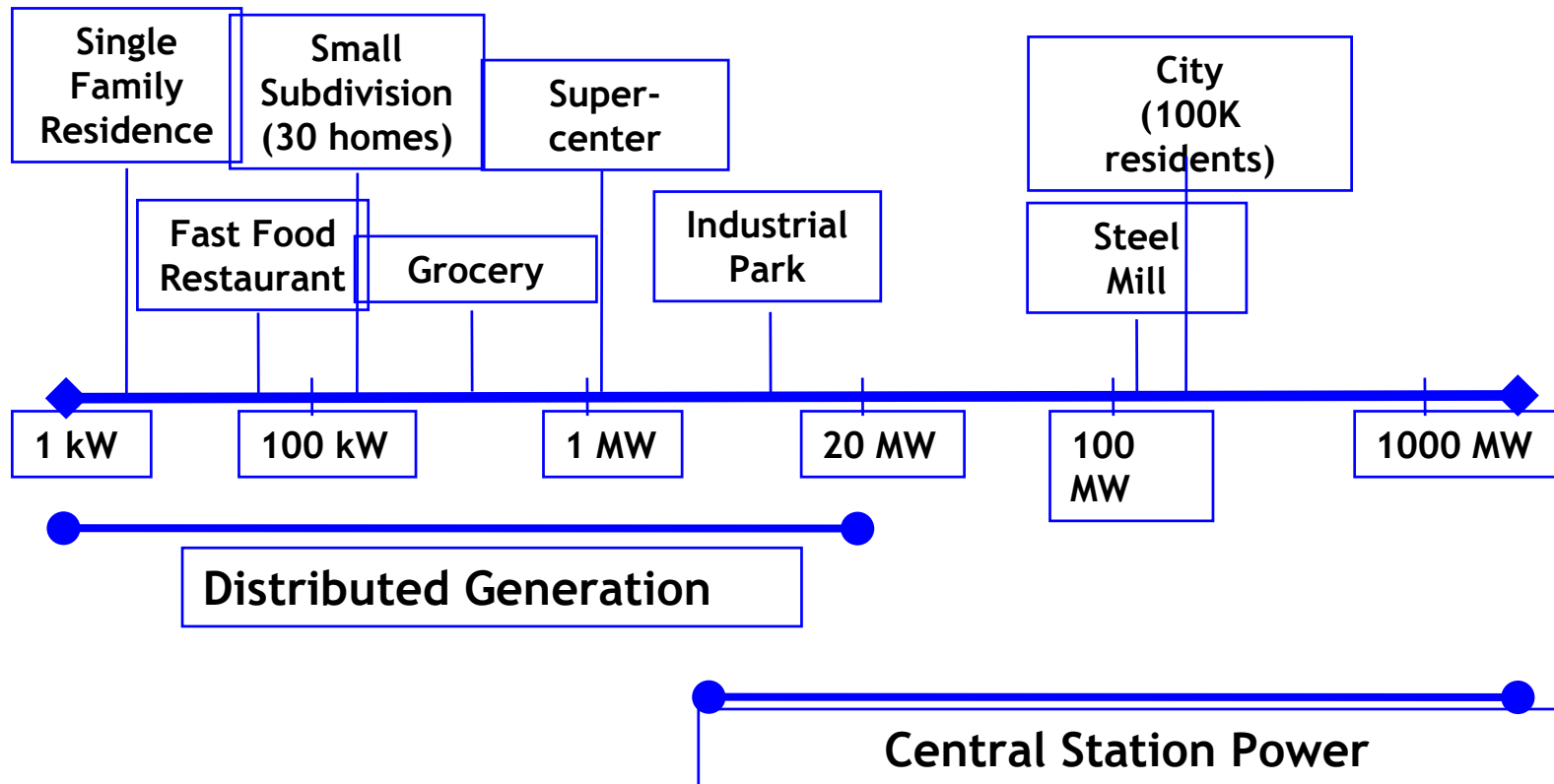
- Peak-shaving
- Prime Power
- Combined Heat & Power (CHP)
- Improved System Reliability

Opportunity!

Thousands of existing standby installations



DG Applications





Distributed Generation Market Factors

Market Factors

Trends and Status

Elect. vs. Gas Prices

Recent trends have both prices moving together.

Demand for Electricity

Demand for power is growing, non-cyclical, at 2-3% per year. Capacity margins remain at low historical levels: 10-15% versus 25-30% in 1980's. DG Installations are growing at double the rate of central plants.

Equip. Cost

Electric only generator costs have not changed much. Recent developments in packaged CHP units have begun to drop prices.

Standardized Utility Interconnect

National interconnect rules have been proposed but not approved. Expect rules to be approved in 2004. Utility's adoption of rules will vary.



DG Market Factors

Market Factors

US DOE Participation

DOE CHP initiative has set goal to double CHP market by 2010. Homeland Security emphasis may impact funding.

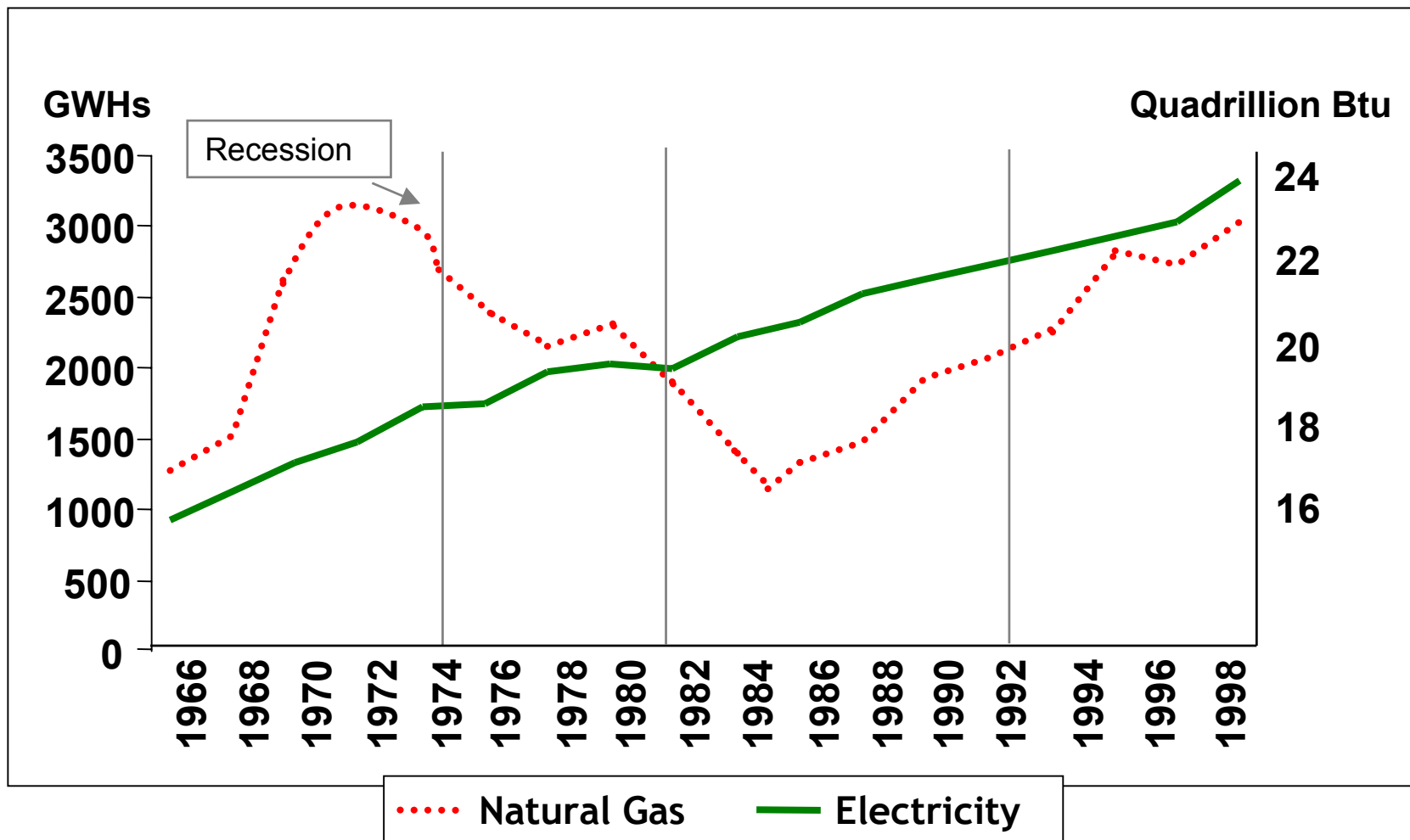
DG Fuel Prices

Fuel prices continue to fluctuate based on weather and demand. Natural gas is fuel of choice and prices have increased due to increased use by new generation.

Trends and Status



Electricity Demand is not Cyclical





DG Market Has Changed

A decade ago

- Diesel-engine-driven Gensets used Primarily for emergency backup
- Building code-driven emergency back-up
- Low installed cost was the key objective

Today

- Increased use of natural gas-fueled Gensets
- Daily and seasonal peaks are higher & capacity reserves continue to shrink
- Growing need for peaking power on more days, for more hours (3000 to 4800 hours per year)
- Businesses have incentives to generate their own power (reliability & cost)
- More options come into play: base load, CHP, peak shaving and standby
- National Interconnection Standards will eliminate barriers



Future Market Potential

- DOE - 247,000 sites have on-site generation (EIA)
- Onsite Generation & CHP market = \$2 - \$4 billion
- 50% of electricity will be used by power sensitive equipment by 2010.
- 20-25% of office bldgs. have onsite generation. 90% is for emergency use only
- Additional generation of 30-90 GW will be required by 2010. Approx. 10% (9 GW) will be DG (Duke Energy Report)
- 20% of new generation in California (1,300 MW) will come from DG (CADER)



Comparison of DG Market Forecasts

Forecast	Period	GW	Comments
DOE Forecast	2000-2020	41	Incremental generation, not defined by size or technology
GRI Baseline	2000-2015	12 50	Incremental large generation Incremental DG, not defined by technology (includes standby
Frost & Sullivan	1996-2004	8 112	Incremental DG from microturbines (100,000 units sold) Incremental DG from other technologies mostly diesel engines (14 GW excluding diesels)
AD Little	2000-2020	48 63	Incremental industrial DG from microturbines Incremental industrial DG from other technologies



National Interconnection Standards



New Interconnection Standards

- Developed to eliminate barriers to installing distributed generation
- Common set of standards
- Reduce time to develop projects
- Allow third party certification

Body of Standards

P1547 Standard for Interconnecting Distributed Resources with Electric Power Systems.

Guide for Network Interconnection

Guide for Grid/DG Impacts

P1614 Guide for Monitoring, Information Exchange and Control of DR Interconnected with EPS (6/02)

Guide for Islanding/Anti-Islanding

**Interconnection
System
Certification
Guide**

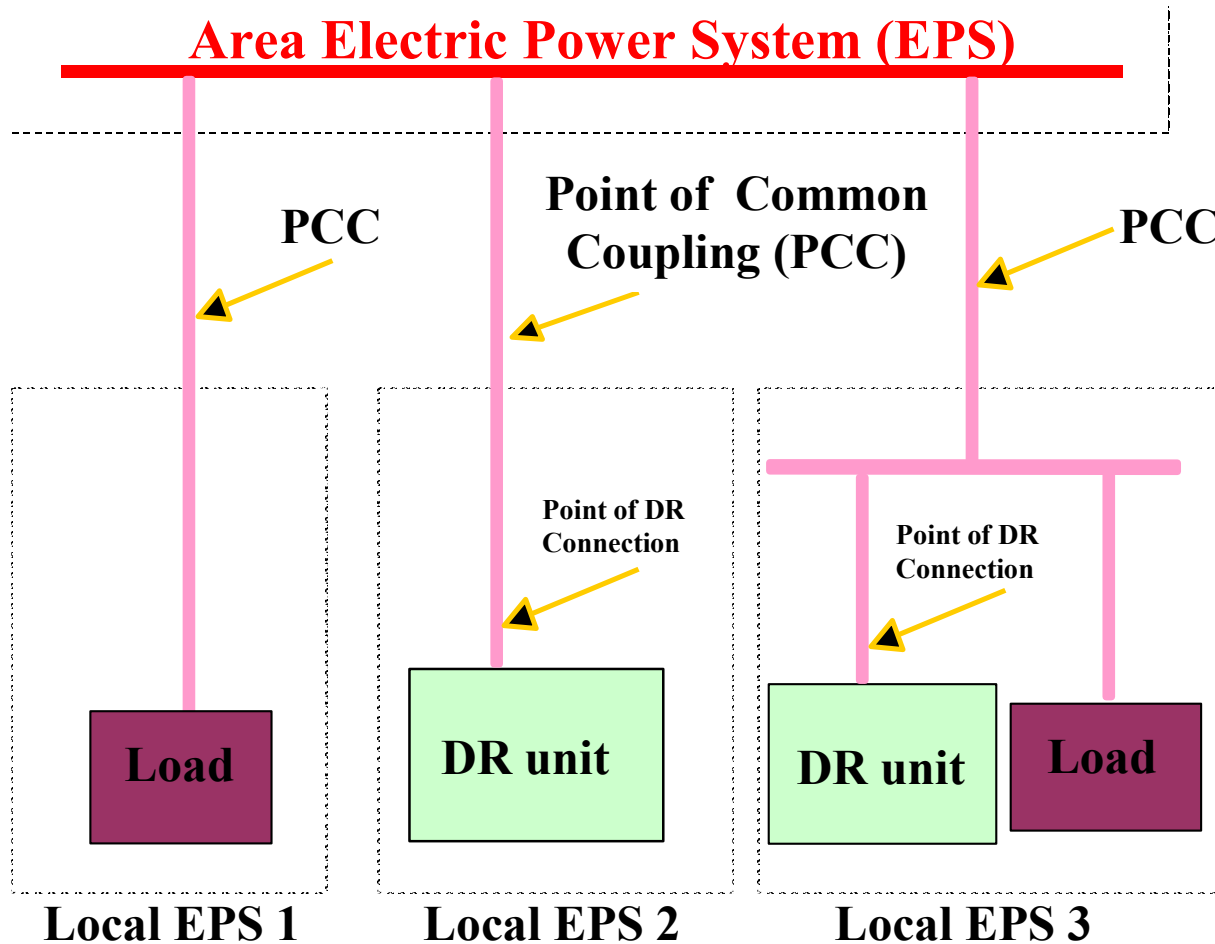
P1608
Application Guide for IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems. 12/01

P1589
Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power System. 6/01

DP Specifications and Performance



P1547 Interconnection Terms



Note: There can be any number of Local EPSs.



Products That Enable Distributed Generation



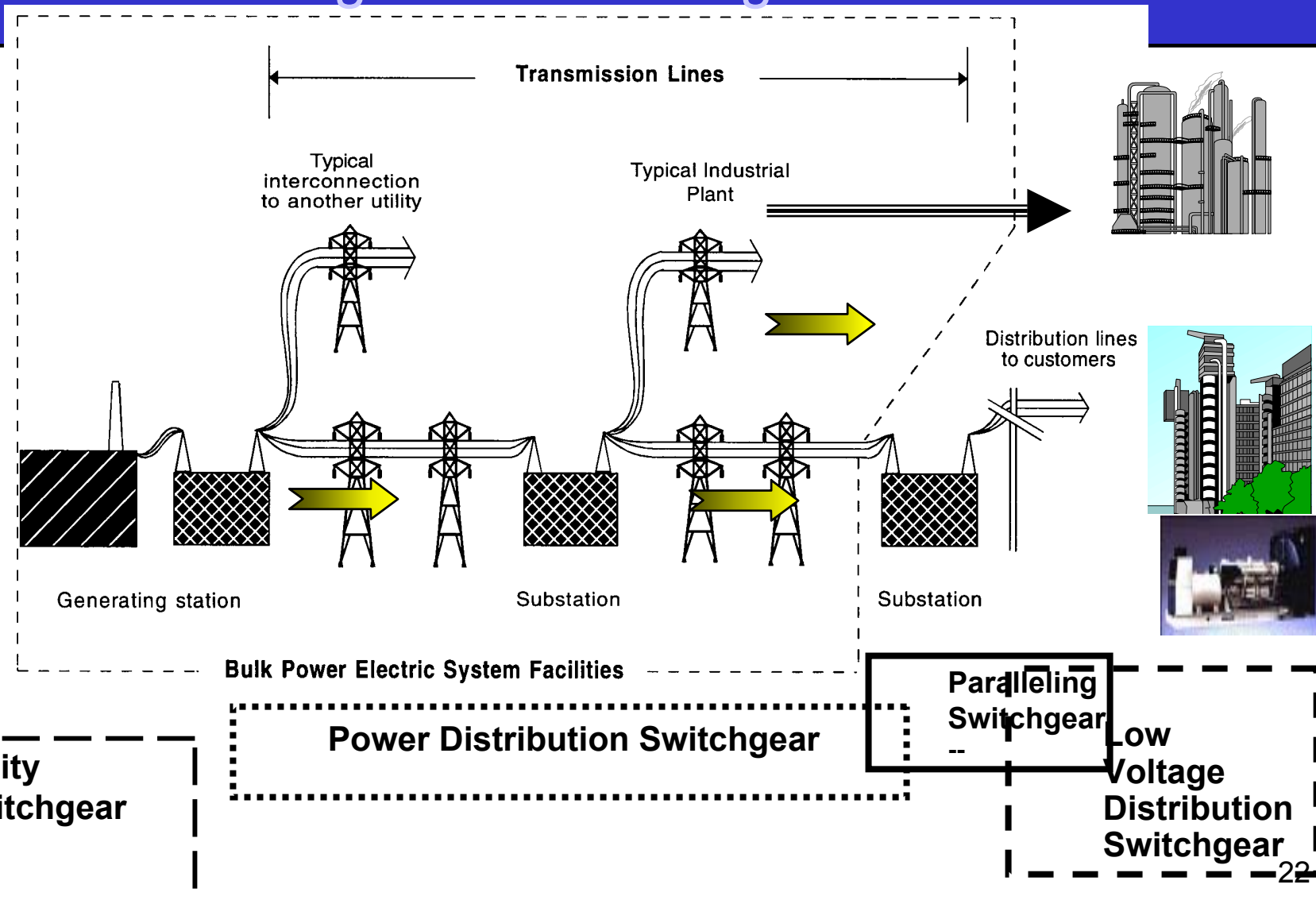


Paralleling Switchgear

- **Used when Synchronous Distributed Generation is paralleled with the Grid**
- **Used to parallel multiple generators to act as a single, larger power system with increased reliability.**



Switchgear Market Segments





Paralleling Switchgear

- PD-75/100
 - Single Generator Parallel to One Utility
- PD-200
 - UL891 Switchboard
- PD-300
 - UL1558 Switchgear
- PD-400
 - UL Listed Medium Voltage



PD-75 and PD-100

- Low voltage (up to 600VAC) single generator parallel to a single utility source
 - Controls
 - Digital control components
 - Touch screen operator interface
 - Operating modes
 - Multiple operation modes
 - Ratings
 - 100-4000 Amp current ratings

Now UL1008
Listed!



PD-75 and PD-100

- PD-75

- Dual breaker
- 100 to 600 Amps

- PD-100

- Dual breaker
- Single breaker
- 800 to 4000 Amps

- Dual breaker

- Emergency standby
- Isolate mode
- Base load generator
- Import / export

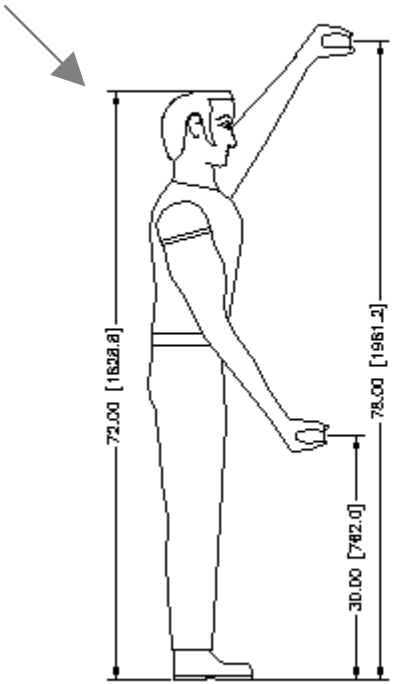
- Single breaker

- Base load generator

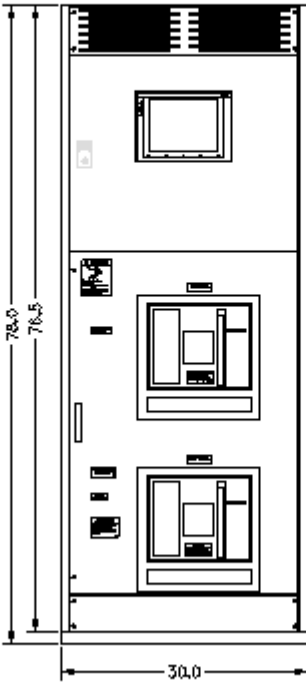


What They Look Like

Standard Man

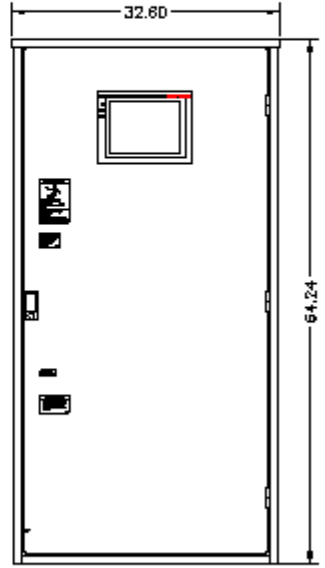


PD-100



FRONT VIEW

PD-75



FRONT VIEW

Modes of Operation

- Emergency/Standby Mode
- Isolate mode (AKA: interruptible rate, load test)
 - Open

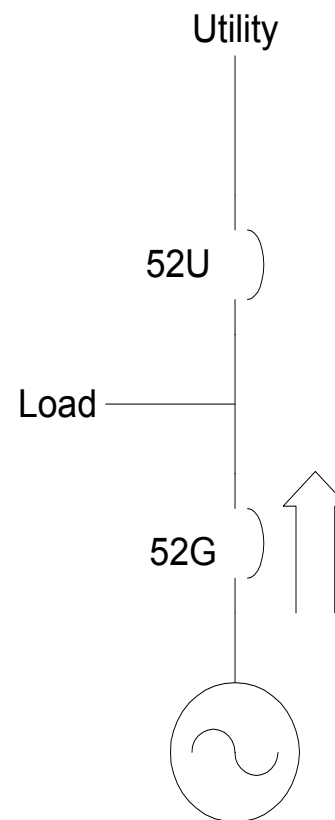
Plant load is transferred from utility to generator. The transfer is break before make
 - Soft Load (Closed)

The generator synchronizes to the utility, the generator breaker closes, the generator ramps up to assume the load. When the utility is unloaded, the utility breaker opens



Modes of Operation

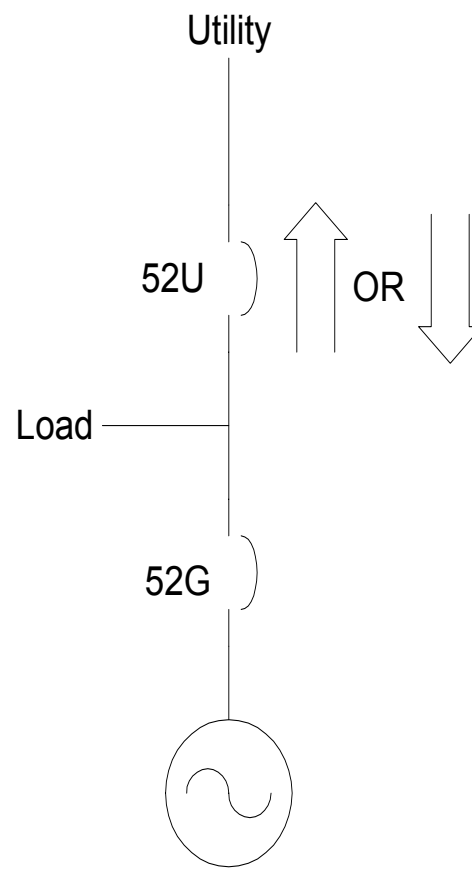
- Base load generator (AKA: peak shave)
 - Generator is loaded to a preset kW level. Generator output remains constant. Utility power fluctuates to meet requirements of the load
 - If generator output is greater than the requirements of the load, the excess power is exported to the utility





Modes of Operation

- Import/Export (AKA: Peak shave)
 - Power flow across the utility intertie is constant. Generator output fluctuates to meet requirements of the load
 - Import - Power flow into system
 - Export - Power flow out of system



Peru Utilities





Peru Utilities



City of Fairfield





City of Fairfield



Utility Call Option Program Summary

- Subsidizes the Standby Purchase
- Downtime is eliminated
- Customer service during outages
 - Able to meet our contractual obligations.
- Labor forces works through outages
- Peak shaving Options
- Future Energy Rate Changes



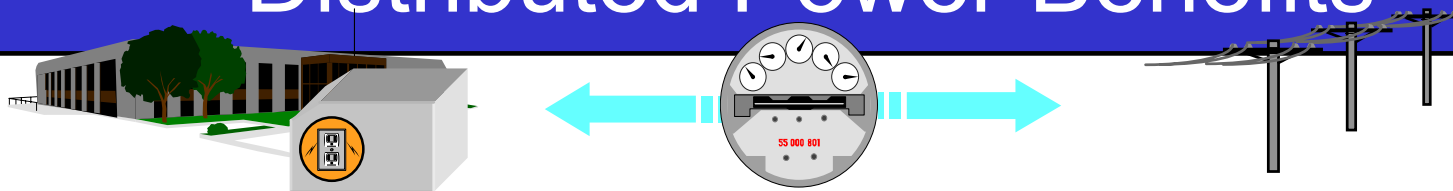
Distributed Generation Summary/Conclusions

Critical Success Factors For DG

- Finance projects and set up lease arrangements
- Low Cost Interconnection equipment and support
- Broad product line of “packaged” CHP products
- Local capability to design and installation systems
- Ability to operate and maintain generators, boilers & chillers
- Metering, monitoring and control systems
- Manage energy price risks



Distributed Power Benefits



Potential Consumer Benefits

- Clean energy
- Lower cost electricity
- Reduced price volatility
- Greater reliability and power quality
- Energy and load management
- Combined Heat and Power

Potential Supplier Benefits

- Reduced electric line loss
- Reduced T&D congestion
- Grid investment deferment and improved grid asset utilization
- Improved grid reliability
- Ancillary services, such as voltage support or stability, VARs, contingency reserves, and black start capability

- **Greater flexibility and energy security**

Customer choice, open market access, time of use pricing, and easy interconnection is required to achieve these benefits

Power Is More Than KW TM

Precision engineered power systems.
Factory trained professionals.
Complete power systems.





Backup Information

Interconnection Standards



IEEE Standards Classification

1. **Standards**: documents with mandatory requirements **(shall)**
2. **Recommended Practices**: documents in which procedures and positions preferred by the IEEE are presented **(should)**
3. **Guides**: documents in which alternative approaches to good practice are suggested but no clear-cut recommendations are made **(may)**

Current SCC21 DR Interconnection Projects

Title	Scope & Purpose
P1547 <u>Standard</u> for Interconnecting Distributed Resources with Electric Power Systems.	<ul style="list-style-type: none">• This <u>Standard</u> establishes criteria and requirements for interconnection of distributed resources (DR) with electric power systems (EPS).• This document provides a uniform standard for interconnection of distributed resources with electric power systems. It provides requirements relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection.
P1589 <u>Standard</u> for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems.	<ul style="list-style-type: none">• This <u>Standard</u> specifies the type, production, and commissioning tests that shall be performed to demonstrate that interconnection functions and equipment of a distributed resource (DR) conform to IEEE Std 1547.• Interconnection equipment that connects distributed resources (DR) to an electric power system (EPS) must meet the requirements specified in IEEE Standard P1547. Standardized test procedures are necessary to establish and verify compliance with those requirements. These test procedures must provide both repeatable results, independent of test location, and flexibility to accommodate a variety of DR technologies.

Current SCC21 DR Interconnection Projects

Title	Scope and Purpose
P1608 Application <u>Guide</u> for IEEE Standard 1547 for Interconnecting Distributed Resources with Electric Power Systems	<ul style="list-style-type: none">• This <u>Guide</u> provides technical background and application details to support the understanding of IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems.• This document facilitates the use of IEEE 1547 by characterizing the various forms of distributed resource technologies and the associated interconnection issues. Additionally, the background and rationale of the technical requirements are discussed in terms of the operation of the distributed resource interconnection with the electric power system. Presented in the document are technical descriptions and schematics, applications guidance and interconnection examples to enhance the use of IEEE 1547.
P1614: <u>Guide</u> for Monitoring, Information Exchange and Control of Distributed Resources Interconnected with Electric Power Systems	<ul style="list-style-type: none">• This document provides guidelines for monitoring, information exchange, and control for distributed resources (DR) interconnected with electric power systems (EPS).• This document facilitates the interoperability of one or more distributed resources interconnected with electric power systems. It describes functionality, parameters and methodologies for monitoring, information exchange and control for the interconnected distributed resources with, or associated with, electric power systems. Distributed resources include systems in the areas of fuel cells, photovoltaics, wind turbines, microturbines, other distributed generators, and, distributed energy storage systems.

IEEE P1547 Contents

4.0 INTERCONNECTION TECHNICAL SPECIFICATIONS AND REQUIREMENTS

4.1 General Requirements

4.2 Response to Area EPS Abnormal Conditions

4.3 Power Quality

4.4 Islanding

5.0 INTERCONNECTION TEST SPECIFICATIONS AND REQUIREMENTS

5.1 Design Test

5.2 Production Tests

5.3 Interconnection Installation Evaluation

5.4 Commissioning Tests

5.5 Periodic Interconnection Tests

- **General Requirements**
 - Voltage Regulation
 - Integration with Area EPS Grounding
 - Synchronization
 - Secondary and Spot Networks
 - **Response to Area EPS Abnormal Conditions**
 - Area EPS Faults
 - Area EPS Reclosing Coordination
 - Voltage
 - **Power Quality**
 - Limitation of DC Injection
 - Harmonics
 - **Islanding**
 - Unintentional Islanding
- Inadvertent Energizing of
 - the Area EPS
 - Monitoring
 - Isolation Device
 - Interconnect Integrity
 -
 - Frequency
 - Loss of Synchronism
 - Reconnection to Area EPS
 -
 - Limitation of Voltage Flicker
 - Induced by the DR
 - Intentional Islanding

P1547 Interconnection Test Requirements

- **Design Test**

- Abnormal Voltage and Frequency
- Synchronization
- Interconnection Integrity

Unintentional Islanding
Limitations of DC Injection
Harmonics

- **Production Tests**

- **Interconnection Installation Evaluation**

- Grounding Integration w/Area EPS
- Isolation Device
- Monitoring Provisions

Area EPS Faults
Area EPS Reclosing

- **Commissioning Tests**

- Unintentional Islanding

- **Periodic Interconnection Tests**

Cease to Energize



Backup Information

Kohler PD-100 and PD-75 Switchgear



PD-75 and PD-100

- PD-75

- Dual breaker
- 100 to 600 Amps

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PD-75



PD-100





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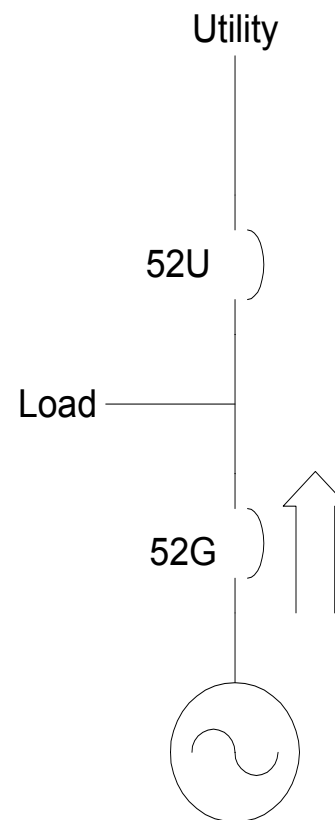
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